Enabling Soldiers with Robots

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USAWC STRATEGY RESEARCH PROJECT

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ABSTRACT

The question is no longer can we create robots to replace traditional human functions, but how do we incorporate robots that meet our moral, ethical, and legal requirements and can be accepted by our organizational culture and doctrine. The capability of robots is undeniable so we must create a vision on how we fight, man, and equip the force as technological advances continue to progress at an ever increasing rate.

ENABLING SOLDIERS WITH ROBOTS

War is and has been an unfortunate reality of humanity. "Although cultures vary widely in how they interpret death and killing from a moral and religious perspective, every human culture has recognized that taking human life is a morally grave matter."[1] The challenge for military professionals is balancing the desire to develop weapons, policy, and doctrine to defeat the anticipated enemies of the state without creating weapons that are deemed unethical or immoral. Mankind has consistently used technological advances to create better and more lethal weapon systems. However, we have also created weapons that have crossed ethical and moral boundaries that have resulted in the banning of these weapons by international law or treaty. Britain's Lord Bingham, retired senior judge, summarized this argument by equating drones with cluster bombs and land mines in that they are weapons that are exceptionally cruel and beyond human tolerance.[2]

Should the United States and specifically the Army as a leader of ground combat technologies develop lethal robots, or should we develop robotic technologies that enable soldiers and provide them with increasing capabilities? Lethal robots, whether remotely controlled or with some minimal level of autonomy, raise significant ethical and moral issues. First, lethal robots that replace soldiers make the decision to go to war too easy for our national leaders. Secondly, lethal robots that target, acquire, and kill humans raise significant ethical issues about maintaining some level of humanity in warfare. Finally, how might our nation and the Army address these ethical issues and develop robotic technologies that enable soldiers to incorporate these new technologies and maximize the potential of the trained military professional.

The question is no longer can we create robots to replace traditional human functions, but how do we incorporate robots that meet our moral, ethical, and legal requirements and can be accepted by our organizational culture and doctrine. The following argument must not be confused with any sort of nostalgia to a more chivalrous past form of warfare. This discussion is in no way a repeat of Sir Douglas Haig's reminiscing of the "value of the horse" years after World War I had fundamentally changed the nature of modern warfare with the adaption of technological advancements and machinery. "But being nostalgic and romanticizing warfare as an extreme sports contest of warriors keen on proving their skills does not really offer a solution to the challenge of technology outpacing soldier skills."[3] Instead we must examine the ethics of robotics so we can best adapt and utilize future advancements.

Understanding why an ethical argument regarding robotics is so much more pervasive than with many other weapon systems is an important distinction. Robots have the unique capability to acquire targets, track, pursue, and then use deadly force with little to no exposure of physical risk to its human operators. The first decade of the 21st century has seen a significant rise in robotic systems used to conduct military tasks in combat. Most notable have been the use of remotely piloted drone aircraft that have delivered lethal munitions against human targets. Drone aircraft have been used extensively in both Pakistan and Yemen in the fight against international terrorists and the Taliban in Afghanistan.[4] While these drone attacks have been exclusively done through the air domain, and with human remote operators and human analysts conducting the targeting, the implications for future development and fielding of robotic

ground attack systems appears to be the next logical step in this technological progression.

This unique robotic capability defines the ethical problem in two ways. First, war can be waged with little to no physical risk to the human combatants or the civilian population of the nation that is employing these robotic weapons. Robots replacing soldiers changes the nation's leaders decision process to enter into war or armed conflict without necessarily changing the violent and destructive nature of war. Secondly, these uniquely capable weapon systems would be used to kill humans with little to no risk to the side using them. Can a nation that sees itself as a moral and value driven society create and use lethal robotic weapons designed to kill humans with little to no physical risk to its combatants or civilian population? Does removing the element of risk or sacrifice from military operations change the nature of war or is this a momentary asymmetrical advantage the United States enjoys? President Abraham Lincoln could not know the future advancements of weapons but he did know what sacrifice and service meant as he made the Gettysburg Address. "From these honored dead we take increased devotion to that cause for which they here, gave the last full measure of devotion – that we here highly resolve these dead shall not have died in vain; that the nation, shall have a new birth of freedom, and that the government of the people by the people for the people, shall not perish from the earth."[5] Do robots diminish the importance of the cause defining why people decide to commit to armed conflict? Lethal robots are more than just precision munitions; they are a completely new classification of technologically advanced weapon systems that may one day largely remove soldiers from the immediate battlefield.

Adopting lethal drones and potentially robotic systems must be a deliberate, morally and ethically debated, decision accepted by American society. Carefully defining the terms of reference for this discussion is a critical first step.[6] Drones or semi-autonomous robots have been used interchangeably throughout and denote constant or near-constant human interaction with the machine and required programming and directions given to the machine in order for the robot to move or carryout missions. Autonomous robots do not rely on human interaction to accomplish tasks once they have been programmed, but instead carryout missions with complex computer software and pre-mission commands. This paper focuses on the ethical discussion of arming drones or semi-autonomous robots and creating remotely controlled weapons with current technology and not necessarily fully autonomous systems. Autonomous weapons are years and most likely decades away from being advanced technologically advanced enough to field based on the incredibly complex nature of ethical decision making.[7]

Lethal Robots and the Ethical Decision to Go to War

Casualty aversion is a major force driving the advancement of robots by the United States. For this discussion casualty aversion describes the perceived attitude of a population prior to the decision to use military force and then how a strategy for the use of force is designed. Senator Warner, Chairman of the Senate Armed Forces Committee from 2003 to 2007, commented on the perceived American casualty aversion during his remarks to Congress in February 2000 by commenting that the American people look forward to future wars being fought with less risk to our service members. He goes on to say that he thinks that this casualty aversion may be unrealistic but also true.[8] This belief is held by numerous national leaders and has

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perpetuated itself amongst political leaders and to some military leaders.[9] This belief

that Americans are casualty averse may not be as pervasive as current conventional

wisdom implies, but it does drive decisions on procurement and the government's use

of military force. From the Congressional statements and actions of the early 2000s, the

2006 Quadrennial Defense Review, and the Department of Defense 'Unmanned

Systems Roadmap 2007-2032'[10] would put a priority on developing and fielding robotic

systems.[11]

　　　To say that the American public would rather not see casualties is obvious and

reasonable. But if the national leadership determines a situation requires the use of

military force then the American public may not be so risk averse. Given the choice

between using military force to protect the nation from a national security threat or to

intervene in a grave international event or not using military force, Americans will

support action even if that action means deploying forces and engaging in armed

combat. Ralph Peters argued that the modern American myth of casualty aversion was

borne out of the Vietnam War, but our nation's leaders took away the wrong lesson

about casualties. "The message of Vietnam is not that Americans will not take

casualties; it is that the American people do not want the lives of their sons and

daughters wasted."[12] Americans want their national leaders to communicate the

justification for war and know that the war will be prosecuted swiftly and effectively.

Americans will support their political leaders but they must see results.[13] Developing

weapons based on a misguided conventional wisdom that the United States should not

expose it service members to harm, but develop and deploy advanced robots to wage

war is patently unethical and disingenuous. President Lincoln understood the gravity of

decision to go to war and bore the weight of the service and sacrifice of soldiers and citizens engaged in a just cause.

The connection between our national leaders, the military members charged with prosecuting operations, and the policy associated with the methods for conducting the war is played out vividly in the use of remotely controlled lethal drones in Pakistan and Afghanistan. Recent statements by United States officials concerning these combat operations, as reported by Reuters, suggest that the United States government has embraced lethal drones. In summary, "It is increasingly the preferred option," "killing militants is simply easier," and "Everyone has fallen in love with them."[14] These statements not only talk to the ease and efficiency of the decision to launch military strikes because of the robotic technology but also because of the perceived lack of potential US casualties. Even when combating the most heinous enemies of the United States, the cavalier statements of these officials can be judged as disturbing.

From our nation's point of view, robotic weapons offer an attractive alternative to deploying soldiers. Even if we believe that we are acting in a moral manner as we decide we must wage war, robotic weapons can be precise and can use proportional force without exposing soldiers to harm. Robots may even be considered more ethical as an evolution of smart weapons.[15] What has actually been borne out in Pakistan is far from clear. Reports of civilian casualties are difficult or impossible to verify, though no one would deny that there have been civilian casualties as a result of the drone strikes. It is also quite possible that these drone attacks have further galvanized the opposition and created another generation of anti-American terrorists.[16]

One clear example of a battlefield success that resonated as a strategic victory for the nation and the President of the United States did not involved lethal robot or drone attacks. The operation to kill or capture Al Qaeda leader Osama bin Laden was done with U.S. Special Operations forces, human intelligence sources, and the hard work of intelligence analysts. Trained professional soldiers using advanced equipment executed a daring mission that resulted in a victory greater than destroying a target. This raid is a clear example of the importance of the human dimension as part of a moral and ethical victory that resonated with the nation.

Developing these weapons to save soldiers can make the nation's decision to wage war seem less costly in terms of their own soldiers and civilians, but where must the nation draw the line. Robert Sparrow, a political philosopher and researcher in Just War theory, articulated this possibility when he stated, "The reason to be worried about the development of more and more sophisticated robotic weapons is that these systems may significantly lower the threshold of conflict and increase the risk of accidental war."[17] As the precision and lethality of modern weapons continues to improve or increase, the application of military force should remain rare and used in only the when national security is at risk or to stop a severe human tragedy. There is a clear moral distinction between improved military capabilities and the ease or increased likelihood that a nation would choose to attack another.

An interesting theory that stems from the connection between our nation's perceived casualty aversion and our development of long range remotely controlled robots is the concern over the United States homeland becoming a more viable target to enemy attack. The operators, considered legal combatants, and the drone bases that

are frequently located in the U.S. are therefore legitimate targets. Attacking an enemy's logistics, command and control, and identified weaknesses are an acceptable form of counter-attack.[18] An unexpected but very possible outcome of developing and fielding long-range robotic weapons where the decision to apply lethal force originates from or are operated out of the United States places the homeland at greater risk to attack. We may very well be developing weapons that protect our soldiers but put our civilian population at greater risk of counter attack.

Improved precision in today's weapons make them terribly or remarkably lethal depending on which side you stand in combat. A nation acting morally may believe that it is protecting its soldiers from the increasingly lethal battlefield by using robots instead of soldiers. But a nation that believes itself a moral actor should not create weapons so lethal that it then cannot participate in what it created to protect its own citizens or soldiers. Armin Krishnan, Professor of Political Science specializing in defense issues and author of the book 'Killer Robots', summarizes this line of thought, "Even if humans would be in complete control of the actions of military robots, the very fact that they are not physically present in an engagement would make the killing seem particularly unfair and unjustifiable."[19]

In P.W. Singer's book "Wired for War," he states in his conclusion a widely held fallacy by the scientific community. "Many, including nearly ever roboticist I met while writing this book, hope that these new technologies will finally end our species' bent toward war."[20] This statement by the engineers who create these weapons seems too simplistic and idealistic. Historically war has not been adverted by more advanced and lethal systems. In the worst case scenario, if history is a predictor of the future, there will

be immoral actors who will use whatever means necessary to terrorize, control, or subdue populations. The possibility of lethal ground based robots tracking down civilians, robots as weapons of terror, and engaging them with deadly force is a frightening scenario. Robots offer precision and improved discrimination as achievable advancements but, in the hands of a less than moral actor, robots could be used in a much less discriminate and a much more brutal manner. Taken to the extreme "robot armies could continue this trend to terrible new levels, allowing even smaller groups of people to dominate larger territories and populations, or commit genocides more quickly and with fewer human collaborators."[21] Future systems may in fact result in the opposite of this idealized ethical warfare but in fact make war more brutal and destructive.[22]

We have a responsibility to develop weapons and technologies that offer improved precision, better ability to discriminate, and improved lethality, but they must also be ethical and adhere to the accepted international norms and treaties. "A range of other weapons have been banned through international treaties for similar reasons. This includes asphyxiating gases, biological weapons and other poisons, expanding bullets (so-called dum-dum) air-delivered incendiary weapons, anti-personnel mines, fragmentary weapons with plastic shrapnel and blinding lasers."[23] It is not difficult to imagine that lethal robots would find themselves among the list of particularly inhumane weapons. Albert Einstein whose research was instrumental to the development of nuclear weapons changed his beliefs later in life and called for nuclear disarmament.[24] Making the decision to go to war should be a thoughtful and laborious process by our national leaders with the involvement of the American society. Designing weapons that

make war appear less expensive in terms of lives lost place our nation at greater risk to ill-planned or even frivolous efforts.

<u>Robots and Ethical War Fighting</u>

The second part of this ethical examination turns to the nature and capabilities of the lethal robot and whether or not this form of weapon is any more ethical or unethical when compared to other weapons. Precision and discrimination or distinction are often cited as important factors in the push towards increasing the use of robots. The concept of discrimination or distinction is the more important of the two attributes. Precision is merely the ability to put a weapon or a weapon's effects on a target, not target selection. "The principle of distinction is there to protect civilians, wounded soldiers, the sick, the mentally ill, and the captives. The law, simply put, is that we must discriminate between combatants and non-combatants and do everything in our power to protect the latter."[25] Robots appear well suited to the modern battlefield and offer many unique advantages over other weapons and human soldiers. Robots do not get tired, hungry, feel fear, or get angry. This combination of attributes makes robotic weapons a very attractive option for any nation seeking advanced weaponry.

While a robot's lack of emotions may seem like a desired trait it also has a very negative downside. Professor Noel Sharkey, Professor of Artificial Intelligence and Robotics, stated "I agree, but they will also not feel sympathy, empathy, compassion, remorse or guilt."[26] Decisions to use deadly force are complex moral decisions that cannot and should not be left to the written code of computer software. "One of the greatest restraints for the cruelty in war has always been the natural inhibition of humans not to kill or hurt fellow human beings."[27] While this argument lends itself to more autonomous systems it is applicable to advanced remotely controlled weapons

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where the operator is thousands of miles away. The weapons we use and develop while lethal and precise should not disconnect humans and our humanity from this most grave human endeavor of deciding to kill another human being.

"More academically, there is the ethical argument that there are certain things that should only be done by human beings and should never be delegated to machines."[28] This lack of moral judgment and human connection that are obvious in a more autonomous robot, are also problematic in the remotely controlled robots. The human operator separated from the physical location of the battle removes himself and by association some of his perception. Even with near perfect situational awareness and control of precision weapons, the operator's lack of physical association with the adversary affects the decision to use deadly force. "In real-world moral and ethical decision-making, humans deliberate. That is, they consider different perspectives and alternatives, and then decide what is right in a given situation."[29] Soldiers need to be able to immerse themselves in the situation in order to effectively discriminate and make proper ethical and moral decisions in complex situations.

Accountability is an important component of this ethical argument. Accountability and legal recourse are powerful tools in managing a soldier's actions and maintaining a disciplined ethical force. Humans can make mistakes or they can act unethically, but individual accountability remains. "It has been argued that even if machines become much more intelligent and comprehend real-life situations, they are still no moral agents. A moral agent has not only the ability to tell right from wrong actions, but has to be able to feel remorse and to be punishable."[30] When lethal robots become involved in war there are many more individuals that become associated with the decision or the act of

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using deadly force. Our national leaders, generals, and soldiers executing the operation have a significant level of responsibility and accountability, but so do the manufacturers, designers, and software programmers.[31]

In the recent conflicts in Iraq and Afghanistan there are been relatively few egregious heinous criminal acts committed by soldiers either on combatants or non-combatants given the hundreds of thousands of soldiers who have served in the two combat theaters. In every documented case of misconduct, soldiers, if found guilty, were prosecuted for their crimes. Human operated robots are unlikely to solve the problem of criminality and may even acerbate the problem by giving a tremendously lethal weapon to a soldier with questionable ethical or moral foundations. This distant soldier with the same personality issues may also be less inclined to associate with the target and might act in a less than acceptable manner.

"Wars are certainly bad in ethical terms, but wars fought without any ethical restraint are many times worse."[32] The weapons we develop and use have tremendous moral and ethical implications. The decision of our nation's leaders to go to war should not be made easier because our soldiers and civilians are not put at risk. Human life either friend or enemy needs to be treated with a certain amount of dignity and respect. The types of robots and technology we develop and field should enable trained professional soldiers and improve their ability to execute their missions within the rule of law and as morally and ethically as possible.

Adapting Technology and War Fighting

A challenge for military professionals throughout history has been incorporating technological advancements into their military formations in order to defeat an adversary. The challenge of incorporating technology into warfare is much larger than

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just a military question. Max Boot argues in his book, "War Made New", that advancements are not just scientific achievements. New technologies are adapted because of human factors, the nation's economics, nationalism, political system, and values. The military existing in this framework then adjusts to incorporate technological advancements without losing or adversely affecting the basic national character. There is a blend of technology and the role of man.[33] Mankind faces for the first time in history the opportunity where he can completely replace himself on the battlefield with machinery. We must fully understand the impact of this new technology not from just a tactical employment standpoint but from a strategic and policy perspective.[34] This is the organizational dilemma for the United States military as it attempts to assess future adversaries and threats, and allocate resources between its soldiers and their equipment.

The Army is and has always been about soldiers. "Well-trained Soldiers are fundamental to realizing any improvements in technology, techniques, or strategy. It is Soldiers who use technology, execute techniques, and accomplish strategies."[35] While the allure of creating a "bloodless" war for the United States and its allies is undeniable, reality and morality demand a different course. Trained professional soldiers have been and continue to be the foundation and strength of the United States land power. President Ronald Reagan stated this eloquently in his first inaugural address, when he said "Above all, we must realize that no arsenal or no weapon in the arsenals of the world is so formidable as the will and moral courage of free men and women."[36] First and foremost when considering the future development and fielding of advanced systems is how these new capabilities enable soldiers to better perform their wartime

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functions. Placing the soldier as the centerpiece of advanced weapons systems ensures we can maximize human potential and the innate ability to problem solve and quickly adapt to changing situations.

The Army's approach to understanding the future is exercised through the Training and Doctrine Command which has written two documents that attempt to capture and define the future of conflict to 2025. "Although the Army must continue to develop technology to meet future challenges, we must emphasize the integration of technology into capable formations commanded by innovative leaders who are comfortable operating under conditions of ambiguity and uncertainty."[37] The Army professional must understand the capabilities and intentions of its adversary to develop and field appropriate weapons and doctrine to defeat that threat or deter future aggression. "The future operational environment will be complex and uncertain, marked by rapid change and a wide range of threats."[38] If this statement is valid, then what course should the Army take in regards to procurement of advanced technologies and robotics? History shows us the trained professional soldier is adaptable, flexible, and intelligent so taking advantage of these inherent qualities, developing enabling robotic technologies, and adapting our policies, strategy and doctrine is the wisest course.

"A continuous cycle of innovation, experimentation, experience, and change is improving the Army's ability to provide dominant and sustained land power to combatant commanders. It is getting newly developed technology to Soldiers faster than previously envisioned."[39] Because of the complexity of modern technology and the rapid pace of innovation the Army will have increasing difficulty requesting or fielding future capabilities. "Recent and ongoing combat experiences, however, as well as analysis of

the future operational environment and emerging threats, highlight the enduring

uncertainty of armed conflict on land and the need for Army forces to fight under

conditions of uncertainty and complexity."[40] The pace of innovation coupled with the

inability to define a future adversary's capabilities forces the Army to broadly define how

future technologies and robots will enable soldiers.

Senator John Warner was instrumental in the initial development and fielding of

robotics by being an outspoken advocate in Congress. His statements strive to bring the

nation's technological superiority to the uniformed services would be the catalyst to

speed up development of military robots.[41] In turn, Congress, acting as a forcing

function to the Army's procurement procedures, set goals in the National Defense

Authorization Act (FY01, H.R. 4205, Sec. 217) in support of the fielding of robotic

systems. The key goal for land forces was that one third of the Army's operational

ground combat vehicles should be unmanned by 2015.[42] While this may seem a

daunting task, the reality is the Army has procured a significant fleet of small,

reconnaissance type robots in support of the counter-IED operations in Operation Iraqi

Freedom and Operation Enduring Freedom. These robots provided valuable insights

into future capabilities as well as being a good template for how future robotic systems

can enable soldiers and provide an innovative solution to an adversary's tactics,

techniques, and procedures.

Recent combat experience in Iraq and Afghanistan has proven the immense

capability and potential for certain robotic applications. In support of movement and

maneuver, small remotely controlled robots assisted engineer missions and soldiers in

clearing routes of improvised explosive devices. These capable, yet relative simple

robots enabled soldiers to accomplish their missions while reducing the threat to the soldiers and their units. The ability of soldiers to understand and see their environment while executing difficult and dangerous tasks was improved. A goal of any system should be improving unit and soldier effectiveness in a complex and ambiguous environment.

These same technologies were used effectively by maneuver forces as intelligence gathering or reconnaissance platforms enabling mounted or dismounted units to observe in front of or on the flanks of maneuvering forces. Robotic systems were used effectively to reconnoiter dangerous situations quickly and effectively prior to exposing soldiers to hazards. Speed and agility can be maintained while providing improved situational awareness which further improves the unit's effectiveness. Reducing soldier risk or risk mitigation is a valuable benefit in developing robotic technologies. "Robots have proven very efficient and cost effective in tasks that are repetitive and dangerous. They are well suited to perform tasks where Soldier lives are at great risk and they can do much to mitigate that risk with little or no reduction to the successful execution of the task."[43] However, risk mitigation is not risk aversion. These soldiers experienced war in close personal proximity with the robots they controlled. They were immersed in their environment and amongst the civilian population conducting themselves in a professional and moral manner.

However, these apparent tactical successes may have had strategic implications for the way we deploy combat forces. Because of our perceived casualty aversion, current technologies and their operational designs focused on maximizing American force protection may actually have been less effective than first thought. The bombing

campaign in Kosovo was designed to save Kosovar Albanians while attempting to reduce US risk to marginal levels. This campaign had mixed results at best and highlights the failed reliance on technology and US force protection as driving operational factors.[44]

This same paradigm appeared in Iraq in the mid 2000s while using robots to combat the improvised explosive device and as intelligence, surveillance, and reconnaissance (ISR) platforms. Simultaneously during this period, U.S. forces were consolidated on large operating bases and restricted to limited prescribed routes and limited mission sets. Concerned about mounting casualties, the Department of Defense focused its efforts on technological solutions and increased force protection measures, not strategic or doctrinal solutions. This risk averse strategy produced marginal results on the ground and security for the Iraqi population and U.S. service members actually declined. But it was a change in U.S. strategy led by General David Petraeus that involved increased human intelligence, more soldier presence and in smaller more dispersed operating bases, and the use of enabling technology that turned the tide in the war and as a result improved U.S. force protection.[45] The counter-insurgency strategy adopted by the U.S. combined enabling technology, soldiers, and other governmental agencies that in the end provided better security for Iraqis, increased force protection for U.S. service members, and ultimately a way for the United States to transition away from combat operations completely by the end of 2011.

Conclusion

Advancing technology has been a consistent factor in developing new weapons and military capabilities. The challenge for a nation that values human rights and the rule of law is how to develop the policy, strategy, and doctrine of incorporating these

new military capabilities and not violate the fundamental values and virtues that make the nation great. Today's technological advancements as witnessed by the rise of robotic technologies are much more rapid and are revolutionary in nature. The use of lethal robots and drones creates profound ethical challenges and cases can be made both for and against their use.[46] Our national leaders have not only approved their use, they have increasing resorted to using them because of their relative ease of employment, precision, and significantly reduced casualties on both sides. Because of these successes, our new defense strategy is frequently based on personal safety and a reliance on advanced technology.[47] The ability to exercise military force with greater precision and at a greater distance requires significant introspection.

The development, procurement, and use of advanced weapons and robots should not make the decision to go to war easier for our national leaders. The nation's perceived casualty aversion combined with lethal robots makes the decision to go to war or use limited military force increasingly more acceptable or perhaps even more likely. Once deployed these weapons remove one of the hallmark strengths of our nation, our professional service members. Our nation's sons and daughters, enabled with the latest military technology and professionally trained and led have proven time and again that soldiers and leaders win wars. Our service members carry with them our nation's values, personal accountability and rule of law that resonates wherever they may deployed.

Weapons and equipment should continue to be designed to take advantage of the trained soldier's ability to overcome adversity and find suitable ethical and moral solutions to the incredibly complex problems that arise in a diverse and fluid operating

environment. Equipping the soldier with the latest technologically advanced robots leverages man's innate abilities by providing better situational awareness, protection, and lethality without compromising our nation's values and commitment to rule of law, human rights, or our cultural values.

Endnotes

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[3] Armin Krishnan, *Killer Robots: Legality and Ethicality of Autonomous Weapons* (Burlington, Vermont: Ashgate Publishing Company, 2009), 138.

[4] Billitteri, "Drone Warfare," 655.

[5] Abraham Lincoln, "The Gettysburg Address," (November 19, 1863).

[6] The terms remote controlled robot and drone are used synonomously throughout this work. Robots are machines that can interact with their environment and execute tasks directed by computer programming and a human operator. The human operator manages the tasks of perception and thinking for the robot as it executes its tasks some distance from the operator.

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